ADST-II-CDRL-DIFMII-9900236
1 November 1999

ADVANCED DISTRIBUTED SIMULATION TECHNOLOGY II (ADST II)

DISTRIBUTED INTERACTIVE FIRE MISSION II CONCEPT EVALUATION PROGRAM (DIFM II CEP)

DO #0116

CDRL AB01

For

FINAL REPORT

DID: (DI-MISC-80711)

20000911 089

For:

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Simulation, Training, and Instrumentation Command
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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

1. AGENCY USE ONLY (Leave blank)	**2. REPORT DATE**	**3. REPORT TYPE AND DATES COVERED**
	01 NOV 1999	FINAL

4. TITLE AND SUBTITLE
Advanced Distributed Simulation Technology II (ADST-II) Distributed Interactive Fire Mission II Concept Evaluation Program Final Report

5. FUNDING NUMBERS
N61339-96-D-0002

6. AUTHOR(S)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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8. PERFORMING ORGANIZATION REPORT NUMBER
ADST-II-CDRL-DIFMII-9900236

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

NAWCTSD/STRICOM
12350 Research Parkway
Orlando, FL 32328-3224

10. SPONSORING / MONITORING AGENCY REPORT NUMBER
CDRL AB01

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for Public release; distribution is unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT ***(Maximum 200 Words)*** The Distributed Interactive Fire Mission II (DIFMII) Concept Evaluation Program (CEP) was an experimental exercise conducted at the Mounted Warfare Test Bed (MWTB) at Fort Knox, KY from September 28, to October 14, 1999. The experiment was performed as Delivery Order (DO) #0116 under the Lockheed Martin Advanced Distributed Simulation Technology II (ADST II) Contract administered by the U.S. Army Simulation, Training, and Instrumentation Command (STRICOM).

The Mounted Maneuver Battle Lab (MMBL), Fort Knox, KY sponsored the experiment. The experiment utilized a synthetic environment that employed virtual simulations to depict an Armor Platoon executing six basic platoon-level scenarios in realistic combat situations in various experimental configurations. The scenarios were executed on the Synthetic Theatre of War - Europe (STOW-E) terrain database using Movement to Contact vignettes. These scenarios were designed into a twenty-eight-trail matrix to induce the platoon leader to make tactical decisions, which affected battle outcomes.

14. SUBJECT TERMS
STRICOM, ADST-II,MMBL, MWTB, FORT KNOX

15. NUMBER OF PAGES
21

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	**18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED**	**19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED**	**20. LIMITATION OF ABSTRACT**

Document Control Information

Revision	Revision History	Date
	Original release	1/11/99

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EXECUTIVE SUMMARY

The Distributed Interactive Fire Mission II (DIFMII) Concept Evaluation Program (CEP) was an experimental exercise conducted at the Mounted Warfare Test Bed (MWTB) at Fort Knox, KY from September 28, to October 14, 1999. The experiment was performed as Delivery Order (DO) #0116 under the Lockheed Martin Advanced Distributed Simulation Technology II (ADST II) Contract administered by the U.S. Army Simulation, Training, and Instrumentation Command (STRICOM).

The Mounted Maneuver Battle Lab (MMBL), Fort Knox, KY sponsored the experiment. The experiment utilized a synthetic environment that employed virtual simulations to depict an Armor Platoon executing six basic platoon-level scenarios in realistic combat situations in various experimental configurations. The scenarios were executed on the Synthetic Theatre of War – Europe (STOW-E) terrain database using Movement to Contact vignettes. These scenarios were designed into a twenty-eight-trail matrix to induce the platoon leader to make tactical decisions, which affected battle outcomes. The objectives of the effort were:

a) To determine the operational effectiveness of an Armor Platoon equipped with alternative DIFM functionality applications during threat engagements in a Force XXI or Army After Next (AAN) tactical environment.

b) To identify software requirements essential to implement DIFM alternatives at Platoon level operations.

c) To serve as a foundation for subsequent evaluation of DIFM growth to support Battalion level, Beyond Line-Of-Sight (BLOS), target intensive, and conceivably combined arms fire distribution.

DIFM is a concept describing integrated multi-agent (distributed) automated fire control systems capable of accepting target information from multiple sources, determining available firing platforms (based on location, activity, and obstacle noninterference), tasking unencumbered shooters, passing fire solution data to assigned platforms, displaying shooter target acquisition indicators to facilitate search and rapid engagement procedures, and consequently optimize shooter survivability. The objective system will encompass computation, display, communication functionality, and will have the capacity to: a) automatically assign search sectors to all shooters, prioritize targets, cue incoming firing data, cue engagement area limits (in the sight reticule), cue no-responsibility (other-assigned) targets for individual shooters, and automatically locate and slew onto assigned targets at the individual shooter level for target assignment functions; and b) determine kill zones and optimal firing positions (through terrain analysis) for subordinate units alerted to maneuvering opponents, project sector entry points of targets for vehicle commanders' early engagement, track friendly forces for improved identification, and prioritize targets for course-of-action determination in a planning context. Integration with programmed Force XXI Battle Command Brigade and Below (FBCB2) functionality is anticipated. On implementation, noted functionality is expected to enhance target assignment efficiency by eliminating extended sector search times and reducing required time for manual target assignment through Frequency Modulation (FM) voice radio. The system also is estimated to support immediate application of individual firing platforms for massing of direct fires on single or multiple targets.

The DIFM II CEP experiment was conducted at the Mounted Warfare Test Bed (MWTB), Fort Knox, KY. The effort employed a combination of existing MWTB assets, such as M1A2 manned simulators and Modular Semi-Automated Forces (ModSAF), as well as a version of the existing Rotorcraft Pilot's Associate (RPA) simulation, modified for ground (tank) combat use.

Development of the software modifications and the initial integration of software models were conducted at the Lockheed Martin Federal Systems (LMFS) facility in Owego, NY from May 24 to September 17, 1999. The final integration phase was completed at the MWTB from September 20-24, 1999.

In accordance with the Government Statement of Work, the experiment's training and test trial window was two (2) weeks. This two week period included time to execute the trial run matrix and additional time scheduled for make-up of non-validated runs, if required.

The entire trial run matrix was executed within the allocated two weeks with no additional time required for make-up of non-validated runs. As a result, a portion of the second week was made available for additional excursion runs.

In accordance with the Government SOW, this Final Report includes a description of the experiment, its conditions and conduct, and lessons learned. This report addresses the interconnectivity of simulation systems, modifications to both ModSAF and the manned simulators, and the integration of Government Furnished software models. This report does not include discussion of data analysis nor conclusions as to whether the customer(s) achieved the objectives of the experiment.

1. INTRODUCTION

1.1 Purpose

The purpose of this Final Report is to document the ADST II effort, which supported DIFM. This report includes a full description of the experiment, its conditions, and lessons learned.

1.2 Contract Overview

The Distributed Interactive Fire Mission II (DIFMII) Concept Evaluation Program (CEP) was an experimental exercise conducted at the Mounted Warfare Test Bed (MWTB) at Fort Knox, KY from September 28, to October 14, 1999. The experiment was performed as Delivery Order (DO) #0116 under the Lockheed Martin Advanced Distributed Simulation Technology II (ADST II) Contract administered by the U.S. Army Simulation, Training, and Instrumentation Command (STRICOM). The Mounted Maneuver Battle Lab (MMBL), Fort Knox, KY sponsored the experiment.

1.3 Experiment Overview.

The DIFM concept arose from a need for superior target sorting and fire distribution capabilities as advanced munitions and commanders' increased battlespace responsibilities were projected for the emerging battlefield. Given expected increases in operating tempo, the ability to rapidly and accurately sort targets and assign fire missions to intermittently available (due to prior fire missions or ammunition availability) and generally moving firing platforms was recognized as a critical requirement to facilitate the required performance on the technology-saturated battlefield. Although "end functionality" to manage the task was identified in the Force XXI Battle Command Brigade and Below (FBCB2) User Functional Description (UFD), details of serial functionality performance and functionality distribution in an operational context, and the operational effectiveness resulting therefrom, remained sketchy and unconfirmed. Therefore, an ongoing assessment of alternative functionality applications and their location was prescribed for further definition of the capability and force integration characteristics necessary to implement DIFM system integration for maximum tactical benefit.

DIFM is a concept describing integrated multi-agent (distributed) automated fire control systems capable of accepting target information from multiple sources, determining available firing platforms (based on location, activity, and obstacle noninterference), tasking unencumbered shooters, passing fire solution data to assigned platforms, displaying shooter target acquisition indicators to facilitate search and rapid engagement procedures, and consequently optimize shooter survivability. The objective system will encompass computation, display, communication functionality, and will have the capacity to: a) automatically assign search sectors to all shooters, prioritize targets, cue incoming firing data, cue engagement area limits (in the sight reticule), cue no-responsibility (other-assigned) targets for individual shooters, and automatically locate and slew onto assigned targets at the individual shooter level for target assignment functions; and b) determine kill zones and optimal firing positions (through terrain analysis) for subordinate units alerted to maneuvering opponents, project sector entry points of targets for vehicle commanders' early engagement, track friendly forces for improved identification, and prioritize targets for course-of-action determination, in a planning context. Integration with programmed FBCB2 functionality is anticipated. On implementation, noted functionality is expected to enhance target assignment efficiency by eliminating extended sector search times and reducing required time for manual target assignment through FM voice radio. The system also is estimated to support immediate application of individual firing platforms for massing of direct fires on single or multiple targets.

The DIFM II CEP experiment was conducted at the Mounted Warfare Test Bed (MWTB), Fort Knox, KY. The effort employed a combination of existing MWTB assets, such as M1A2 manned simulators and Modular Semi-Automated Forces (ModSAF), as well as a version of the existing Rotorcraft Pilot's Associate (RPA) simulation, modified for ground (tank) combat use.

1.4 Technical Overview

The technical approach to the DIFM II experiment involved the analysis of the initial DIFM experiment, analysis of new requirements for DIFM II, enhancements to the initial software from the previous effort, and the development of new software to meet the DIFM II requirements. The initial software development and enhancement effort took place at the LMFS facility in Owego, NY from May 24 to September 17, 1999. During this initial phase one Technical Interchange Meeting (TIM) was conducted at the Owego, NY facility and one at the MWTB. The purpose of the TIMs was to assess the development efforts to date and obtain customer approval and additional guidance. Upon completion of the initial software development, the software and its associated hardware were shipped and reinstalled at the MWTB. It took five days to complete the on-site integration at the MWTB. Once the synthetic environment functional tests were completed, the engineers conducted troop training and a Pilot Test. A Test Readiness Review (TRR) was held on September 28, 1999. At the TRR permission was given to freeze the software configuration and approval was given to start the experiment, which began on September 28, 1999. The actual experiment period ran through October 14, 1999 during which 30 different iterations were executed using six basic scenarios. The trial matrix was completed ahead of schedule and the additional time was used to conduct excursion runs.

2. Applicable Documents

2.1 Government

-ADST II Work Statement for Distributed Interactive Fire Mission II (DIFMII) Concept Evaluation Program (CEP), April 26, 1999, AMSTI-99-WO41, Version 1.0

2.2 Non-Government

- None

3. System Description

3.1 System Configuration and Layout

The Mounted Warfare Test Bed at Fort Knox, KY, contains a variety of vehicle simulators, networks, Semi-Automated Forces (SAF) capabilities, displays for monitoring the battlefield, utilities to facilitate exercises, automated data collection capabilities, and data reduction and analysis subsystems. The MWTB simulation and support platforms used for DIFM II are depicted in Figure 1.

DIFM II Floor Plan

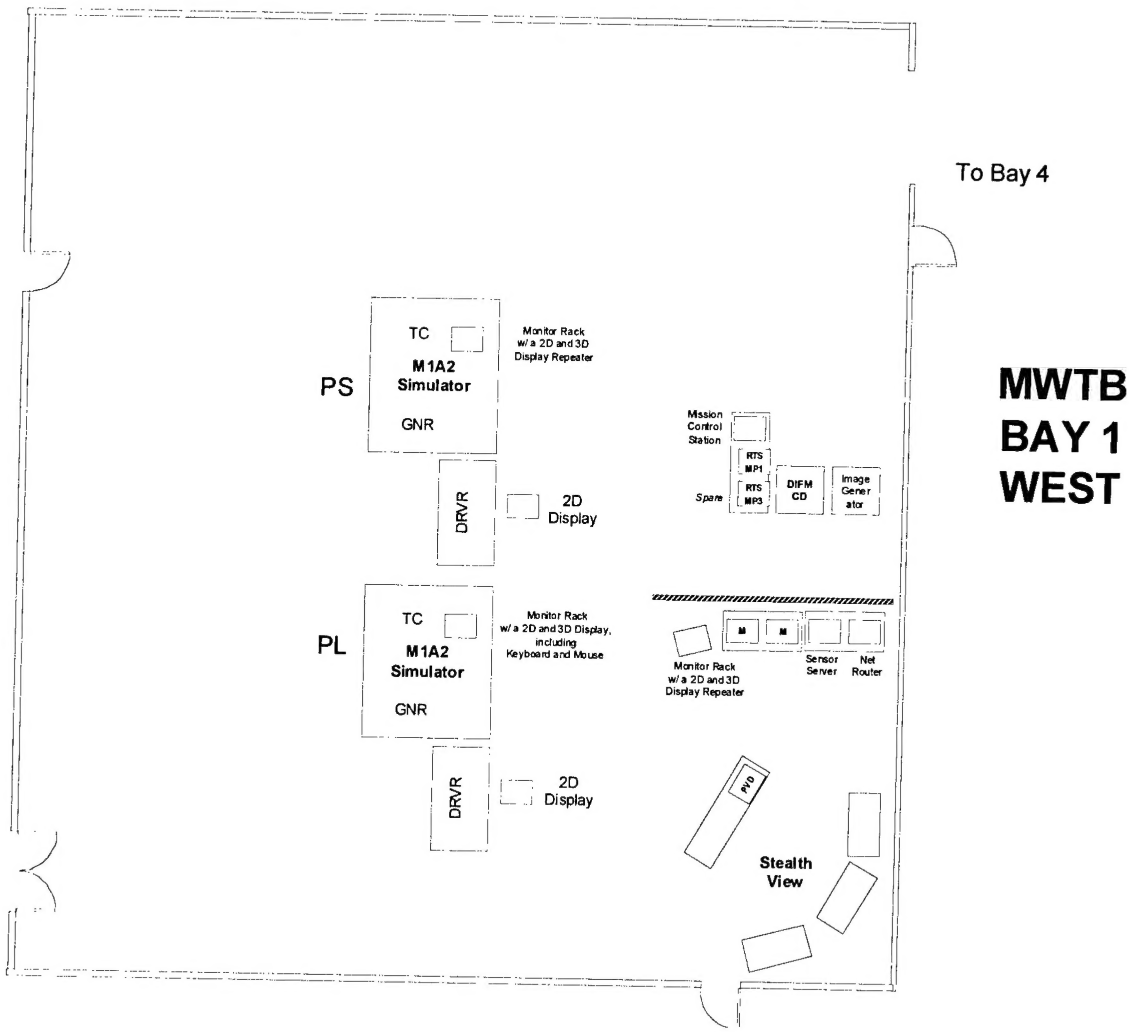

Figure 1 DIFM Floor Plan

The experiment was conducted using assets interconnected on Ethernet Local Area Networks (LANs) via thin net cable. Simulation assets used Distributed Interactive Simulation (DIS) 2.03 protocol. Table 1 lists assets used at the MWTB.

ADST II ASSET	PURPOSE	PROTOCOL
Modified M1A2 Simulators (2)	M1A2 Simulator for Tank Platoon Leader and Tank Platoon Sergeant	DIS
Stealth	Battlefield Display for observation of the battlefield	DIS
ModSAF Workstations (2)	Semi-Automated Forces for OPFOR, & two BLUFOR M1A2 Tanks	DIS
Plan View Display	Terrain Map of the battlefield for Exercise Control	DIS
Data Loggers	Record of DIS PDUs for Data Collection & Analysis	DIS
DIS Time Stamper	Time Stamp of DIS PDUs for Data Collection & Analysis	DIS

Table 1 MWTB Assets

3.2 Description of System Components

This section discusses the description, functionality and operation of the system components, which includes the Government Furnished Equipment (GFE) models and their integration with the hardware at the MWTB.

3.2.1 M1A2 Simulator

Two M1A2 simulators were used for DIFM II. The simulators represented the Tank Platoon Leader and the Platoon Sergeant's tank as part of an Armor Platoon. The simulators were modified to replicate the DIFM II hardware. The Tactical Display was mounted to the left of the Tank Commander (TC) in the manned simulators. It provided the commander with a color map showing accurate terrain profile and route information data, timely Platoon member locations, threat warnings, and map overlays. The Wingman GUI device was installed to provide the driver with a color moving map display overlaid with his scan sector, route and friendly and enemy locations.

3.2.2 Commander's Decision Aid

The Commander's Decision Aid (DA) was a version of the Rotorcraft Pilot's Associate Decision Aiding System, modified for ground (tank) combat. The DA consisted of software executing in a Real-Time Symmetric Multiprocessor (RTSMP) computer. The RTSMP, developed for RPA, consists of eight 150MHz PowerPC processors and both local and global memory. The SGI processor consists of 12 150MHz R4000 processors. Both the RTSMP and the SGI were provided by AATD. The primary functions provided by the DA were:

a. Common Relevant Picture (CRP) - The DA provided a CRP of the battlespace, superimposing the location and type of all known enemy and friendly units on plan and perspective digital maps. This picture also depicted the commander's battle graphics (phase lines, zone boundaries, engagement areas, battle positions, routes and scan sectors.)

b. Mission Replanner - Upon receipt of a change of mission message, the DA recommended a new mission plan to the crew. The mission plan included battle positions and routes.

c. Scan Sectors - The DA allowed the battle commander to "draw" scan sectors for each teammate and when completed assign and distribute them to the team.

d. Battlefield Assessor - DA continually monitored the battlefield situation. Whenever changes in the battlefield situation warranted modifications to the route plan, appropriate plan modifications were recommended to the crew.

e. Wignman GUI - The Wingman Graphical User Interface (GUI) software was developed by Kouwen-Hoven & Hoskins in conjunction with Lockheed Martin Federal Systems for the Distributed Interactive Fire Mission (DIFM) Program. The Wingman GUI device provides a situational awareness display that can be used by a tank driver or tank commander. This GUI provides a display of platoon vehicles ("own vehicle" and wingmen), battlefield entities, the route plan, "own vehicle" scan sector and the current engagement area. The Wingman GUI displays the scan sector assigned to the vehicle in which it is located (the scan sector is not labeled on the GUI display).

3.2.3 ModSAF Operations

ModSAF version 4.0 was used for DIFM. ModSAF was used for Blue Force (BLUFOR) round-out and Opposing Force (OPFOR). BLUFOR ModSAF provided the two additional tanks required to round-out the Armor Platoon. OPFOR were provided in a configuration of a Motorized Rifle Company to complete the scenario requirements. ModSAF was used on two SGI Indy platforms.

3.2.4 Data Logger

The Data Logger is an ADST II asset that captures the network traffic and places the data packets on a disk or tape file. The Data Logger performs the following functions:

a. Packet Recording - Receives packets from the DIS network, time stamps and then writes to a disk or tape.

b. Packet Playback - Packets from a recorded exercise can be transmitted in real time or faster than real time. The Data Logger can also suspend playback (freeze time) and skip backward or forward to a designated point in time. The logger can be controlled directly from the keyboard or remotely from the Plan View Display (PVD). Playback is visible to any device on the network (PVD, Stealth Vehicle, a vehicle simulator, etc.).

c. Copying or Converting - Files are copied to another file, which can be on the same or a different medium; and files from the older version of the Data Logger can be converted to a format compatible with the current version of the Data Logger.

For the exercise, two data loggers were employed to capture the exercise. The two data loggers were placed on the DIS net to capture all DIS PDUs for analysis. These two loggers used Sun IPX systems with 48 MB RAM, 1 GB Hard drive, and the Sun OS 4.1.3 operating system. One data logger was designated as a back up and was not needed.

3.2.5 Sensor Server

The sensor server was a SUN Sparc 20 workstation. It was running modified ModSAF 3.0 software that would receive DIS 2.03 data packets on User Datagram Protocol (UDP) port 3000 (real world) and pass them to UDP port 3010 (sensed world) if they were friendly entities or enemy entities that had been sensed by blue intelligence. This provided the ability to take a "standard" simulation tool, such as a Stealth or ModSAF PVD, and use it as a more enhanced C2 system, displaying Blue Forces

(BLUFOR) Situation Awareness (SA) as well as sensed/detected OPFOR. Real world and sensed world used the same physical network. Additional technical data on the Sensor Served can be found in the BCR III Version Description document ADSTII-CDRL-BCRIII-9900219.

3.2.6 Network Router

The Network Router is an application that allows different subnets to be joined according to rules appropriate to the experiment. The DIFM II experiment called for Scan Sector Limit Indicators (LIs) that are visible from the manned simulators. These LIs provide an indication to the simulator's crew of the commander's desired scan limits. Each simulator's LIs should only be visible from that simulator.

For the DIFM II experiment, the Network Router joined the following four subnets:

a. Overall simulation network (port 3000). This network contains Protocol Data Units (PDUs) for all simulated vehicles. It does not contain any PDUs from Posts. No simulations are directly attached to this network.

b. M1A2 network (port 3081). This network contains contains PDUs for all simulated vehicles. It also contains the LIs intended for the M1A2 manned simulator. The M1A2 simulator is directly attached to this network.

c. ModSAF network (port 3033). This network contains PDUs for all simulated vehicles. It also contains the LIs intended for any ModSAF vehicle. The ModSAFs are directly attached to this network.

The process starts when the DIFM sends a Scan Sector PDU, which is defined as:

```
typedef struct {
    DIS203_PDU_HEADER_RECORD              pdu_header;
    DIS203_ENTITY_ID_RECORD               sender_id;
    DIS203_ENTITY_ID_RECORD               target_id;
    uint32                  state;
    uint32                  pad;
    DIS203_WORLD_COORDINATES_RECORD       origin;
    DIS203_WORLD_COORDINATES_RECORD       left_ray;
    DIS203_WORLD_COORDINATES_RECORD       right_ray;
    float32                 field_of_view;
    float32                 heading;
    float32                 range;
} DIS203_SCAN_SECTOR_PDU;
#define DIS203_SCAN_SECTOR_PDU_KIND    186
#define SCAN_SECTOR_STATE_ACTIVE      0
#define SCAN_SECTOR_STATE_INACTIVE    1
```

The important fields are target_id (the simulator that should see the LIs), and the origin, left_ray, and right_ray locations. When the Network Router receives a Scan Sector PDU, it calculates LI locations using the origin, left_ray, and right_ray locations. The left LI will be 200 meters from the origin

along the origin-left_ray vector. If there is no intervisibility to that location, a new location closest to the origin will be determined, until intervisibility exists. The process is repeated for the right LI. Entity_State PDUs for the LIs are then transmitted on the appropriate subnet. The LIs enumeration is that of a Line Pair Target Board. Entity_State PDUs will be periodically generated for each LI until a Scan Sector PDU is received with the state field equal to SCAN_SECTOR_STATE_INACTIVE. The network diagram is shown in figure 2. The manned simulator receives the PDU, and tells its IG to paint the Limit Indicators in the Gunner's sight.

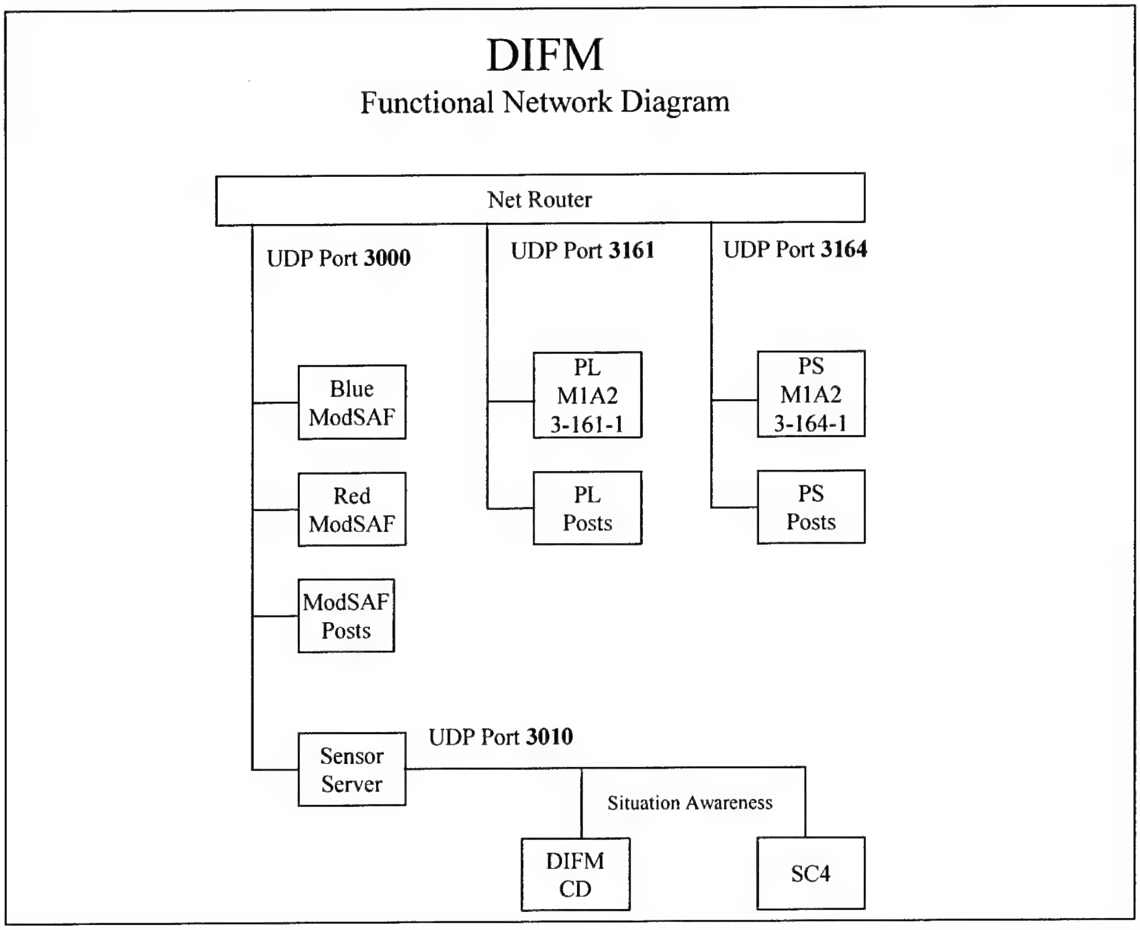

Figure 2. Network Diagram

3.2.7 Time Stamper

The MWTB provided a Time Stamper, which consisted of a video time code generator. This time code generator produced time data in days, since 1 January, in hour/min/sec format. It also ran on an IBM-compatible Personal Computer (PC). The PC was programmed to read the video time code, convert the time data, and then generate a Time PDU which was then issued on the DIS network each second. This provided the real world clock time on the logged data to assist in subsequent analyses.

3.2.8 Stealth System

The SGI ONYX RE Stealth (Level II IG) was used during DIFM II with the M1A2 simulators. The Stealth gives the Observer/Controller (O/C) personnel a "window" into the virtual battlefield allowing them to make covert observations of the action occurring during the scenario. In addition, through the use of the data logger, the Stealth gives observers and analysts an After Action Review(AAR) capability. The Stealth is a visual display platform that consists of a PVD, various input devices, and three video displays that provide the operator with a panoramic, 3D view of the battlefield.

The Stealth permits the controller to fly around the virtual battlefield and view the simulation without interfering with the action. The features of the Stealth allow the observer to survey the virtual battlefield from a variety of different perspectives, including:

a. Tethered View - Allows the user to attach unnoticed to any vehicle on the virtual battlefield.

b. Mimic View - Places the user in any vehicle on the virtual battlefield and provides the same view as the vehicle commander.

c. Orbit View - Allows the operator to remain attached to any vehicle on the virtual battlefield and to rotate 360° about that vehicle, while still maintaining the vehicle as a center point of view.

d. Free Fly Mode - Permits independent 3-D movement anywhere in the virtual battlefield.

3.2.9 Database Development

The existing ADST II STOW-E terrain database was used to support the experiment. The database was 50 Km by 50 Km and was used with sunshine and rain weather conditions.

The DA software utilizes many terrain-referenced databases. As designed for RPA, these databases can all be created from standard real world Defense Mapping Agency (DMA) products. For DIFM, the STOW-E database utilized data in a format called Compact Terrain Database (CTDB). Because of differences between this simulated STOW-E data format and the format of DMA data changes were necessary. This initial database creation process resulted in a number of alignment problems which were resolved by:

- Converting ARSI and ModSAF GCC data to TCC for use by DIFM S/W directly
- Converting ModSAF projection for STOWE
- Modifying DIFM C&D UTM readout to display 5 character UTM format
- Modifying DIFM C&D UTM conversion to use UTM projection
- Adding Tree Line features to the DFAD database prior to creation of the Discernability database.

The M1A2 Tank Simulators and the ModSAF Players at the MMBL can't drive, see or shoot through the trees/tree lines. On RPA, trees are not considered blocking terrain. Therefore, for DIFM DAS, functions that utilize terrain databases for computing LOS were modified to properly account for trees:

- DIFM S/W & Database Structure was modified to utilize multiple databases:
- Elevation Data without trees for plan view map, elevation contour lines and algorithms that require ground elevation
- Elevation Data with trees for line-of-sight calculations
- Trees and buildings block line-of-sight (LOS) from friendly vehicles to threats and from threats to friendly vehicles and to their planned routes.

- For LOS computations, the elevation of friendly and enemy vehicles is conservatively set to the highest terrain within 100 meters.
- For LOS computations, the elevation of enemy vehicles is conservatively set to the highest terrain within 100 meters
- To be "safest", the elevation of the intervening terrain and features is assumed to be the lowest altitude within 100 meters.

3.2.10 Scenario Development

A series of six test scenarios and one training scenario were developed to support DIFM II (see section 4.3). Each scenario contained four vignettes that depicted an Armor Platoon conducting Movement to Contact (MTC) tasks. The scenarios included Operations Orders (OPORD), Fragmentary Orders (FRAGO) and overlays to support the mission. The orders and overlays were developed by the Mounted Maneuver Battle Lab and Lockheed Martin Service Group (LMSG) MWTB personnel. The ModSAF scenarios and graphics are on tape and in the ADST II Configuration Management Library on tape MD0961.

4. Conduct of The Experiment

4.1 Troop Training

In order to get the maximum benefit from the Pilot Test, a three day period of time was set aside for troop training to bring the soldiers and Research Assistants up to a level of confidence on the systems prior to the Pilot Test. This troop training was conducted at the MWTB from September 21 to September 27, 1999.

4.2 Pilot Test

The Pilot Test was conducted at the MWTB on September 27, 1999. During this time, the soldiers used the skills acquired in troop training to conduct tactical operations in a scenario specially designed to stress the systems and the soldier's skills. During this time special attention was given to focus on technical anomalies that appeared. No issues came up in the Pilot Test.

Following the Pilot Test, a time was set aside to conduct a TRR to discuss the status of the system. The TRR was held on September 28, 1999. At the TRR no issues emerged.

4.3 Experiment and Trial Runs

The trial runs for the experiment began on September 28, 1999. The complete trial matrix for a total of 30 runs was completed ahead of schedule and the remaining time was used for additional excursion runs. The experimental unit was a Tank Platoon. Manned entities were one Platoon Leader and Platoon Sergeant. The remainder of the Platoon was provided by ModSAF. Table 2 defines the system configuration and scenario used in each trial.

DIFM EXPERIMENT MATRIX
DIFM2
RUN MATRIX
(10 Sep 99)

Study Variables:

RPA	Route Distance	Route Terrain Character(RTC)	# Enroute FRAGOs	Sunshade	Contour Lines	KHH
Yes	Short (10k)	Simple	1	Yes	Yes	Yes
No	Long (15k)	Rough	2	No	No	No

Case Matrix:

Case	Player	RPA	RTC	Distance	#FRAGO	Sunshade	C Lines	KHH
1	1	No	Simple	Short	1	Yes	No	No
2	1	No	Simple	Short	1	Yes	Yes	No
3	1	No	Simple	Short	1	No	Yes	No
4	1	No	Rough	Long	1	Yes	Yes	No
5	1	Yes	Rough	Long	1	Yes	No	No
6	1	Yes	Rough	Long	1	Yes	Yes	No
7	1	Yes	Rough	Long	1	No	Yes	No
8	1	Yes	Rough	Long	2	Yes	Yes	No
9	1	Yes	Rough	Long	3	Yes	Yes	No
10	1	Yes	Rough	Long	3	Yes	No	No
11	1	Yes	Rough	Long	3	No	Yes	No
12	1	Yes	Rough	Long	1	Yes	No	Yes
13	1	Yes	Rough	Long	1	Yes	Yes	Yes
14	1	Yes	Rough	Long	1	No	Yes	Yes
15	1	Yes	Rough	Long	3	Yes	Yes	Yes
16	2	No	Simple	Short	1	Yes	No	No
17	2	No	Simple	Short	1	Yes	Yes	No
18	2	No	Simple	Short	1	No	Yes	No
19	2	No	Rough	Long	1	Yes	Yes	No
20	2	Yes	Rough	Long	1	Yes	No	No
21	2	Yes	Rough	Long	1	Yes	Yes	No
22	2	Yes	Rough	Long	1	No	Yes	No
23	2	Yes	Rough	Long	2	Yes	Yes	No
24	2	Yes	Rough	Long	3	Yes	Yes	No
25	2	Yes	Rough	Long	3	Yes	No	No
26	2	Yes	Rough	Long	3	No	Yes	No
27	2	Yes	Rough	Long	1	Yes	No	Yes
28	2	Yes	Rough	Long	1	Yes	Yes	Yes
29	2	Yes	Rough	Long	1	No	Yes	Yes
30	2	Yes	Rough	Long	3	Yes	Yes	Yes

'KHH' indicates Kouwen-Hoven & Hoskins 'Peregrine Map System'.

Table 2 Experiment Matrix

5. Observations and Lessons Learned

a) Integrated Product Team.

Observation: The Integrated Product Team (IPT) process worked extremely well.

Discussion: This experiment was a follow-on to the previous DIFM effort. In the original DIFM experiment several items were recommended for enhancements. Due to time and budget considerations all the enhancements could not be implemented. Through the IPT process with the customer and the developer an excellent dialogue was established. The customer established a priority list and each enhancement was costed separately by the developer. The cost elements and the priority lost were then combined and a final list of enhancements was developed and implemented. It was through this process that the best and most cost efficient enhancements were implemented.

Lesson Learned: The IPT is an excellent tool to use throughout a program and this effort should be used as an example for future efforts.

b) Terrain Feature Impact on Intervisibility

Observation: Special processing implemented to consider trees and other man-made features as blocking terrain significantly enhanced functions that rely on line-of-sight processing.

Discussion: The RPA DA software does not consider terrain features like trees when computing exposure of one position to another. RPA took this approach since at altitude, terrain features are often less of a factor; aviation sensors can often see through the feature (RF, IR); and currently available databases do not represent terrain features like trees with much accuracy. However, during the January 1999 DIFM Experiment it was concluded that for ground combat terrain features like tree lines must be considered by the DA. Therefore, these features were added to the databases and special processing implemented to handle them as blocking terrain. More details on these databases and processing are included in section 3.2.9.

Lesson Learned: For ground combat, terrain features like tree lines must be considered by the Decision Aid. This will drive the requirement for accurate mapping of battlefield terrain.

c) Scan Sector IV

Observation: Displaying the terrain visible from the vertex of each scan sector enhanced the ability of the commander to develop the attack plan.

Discussion: For the January 1999 DIFM experiment, a capability was provided that allowed the commander to create scan sectors for the team and overlay them on the tactical situation display / digital map. This capability was very useful to the commander, but required either manual, or a keystroke intensive task to analyze terrain blockage. As an enhancement for this DIFM experiment, the Decision Aid automatically computed and displayed the terrain visible from the vertex of each scan sector.

Lesson Learned: Functions that enhance the commanders ability to visualize the battlefield, battle graphics, friendly and enemy positions are extremely valuable in helping the human operator make better decisions; sometimes more so than more complex “fully automatic” functions.

d) Wingman GUI

Observation: Providing the driver with his own tactical situation display / map greatly enhanced his ability to execute the plan.

Discussion: For the January 1999 DIFM experiment, the driver was provided with a repeater display of the commander’s tactical situation display / map. On this display he could see the route only if the commander was not panned to a different location. In addition, the range scale was often not set to optimize the driver’s view around the vehicle. For this most recent experiment, a separate display,

called the Wingman GUI, was added to the system, giving the driver his own dedicated display with independent pan and range-scale control.

Lesson Learned: Providing the driver with his own display should be strongly consider for any future implementation of DIFM technology.

e) Operating Area

Observation: The rugged terrain chosen for the operating area detracted from evaluation of the DIFM DA.

Discussion: The terrain in the mission operating area was very rugged. This significantly complicated mission execution in the M1A2 simulators. For example, the drivers often got their tanks "stuck" or "damaged" enroute to the engagement areas. This increased the time for each trial and, in many cases, detracted from evaluation of the DIFM technologies.

Lesson Learned: Choose operating area / terrain to avoid adding unwanted complexities to the experiment.

f) Training

Observation: There is seldom too much training.

Discussion: For this DIFM experiment only one solider / operator was experienced from the January 1999 experiment; the others were new to the system. Three days hands-on training was provided. Although this training was adequate for basic system operation, it failed to provide the experience necessary to deal with some of the off-nominal, time critical events that occurred during the experiment.

Lesson Learned: The capabilities of digital technologies offer the promise of greatly improving force effectiveness. However, sufficient training must be provided to allow the crews to correctly use the technologies and in the case of Decision Aids, the experience necessary to trust the technology.

6. Conclusion

The DIFM II experiment was a technically complex effort that achieved its goal. Enhancements to the initial DIFM software improved the product. The enhancements from the initial DIFM effort included the synchronization of the ModSAF databases, route planner enhancements and display changes. The successful integration of multiple GFE software models into the MWTB hardware provided the desired synthetic environment for the customers. This environment allowed them to analyze and evaluate the resulting data to assist in developing better force protection, increased survivability, and enhanced command and control procedures. Combined, these enhancements will better preserve the force in combat operations.

7. Points of Contact

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Acronym List

AAN	Army After Next
AAR	After Action Review
ADST	Advanced Distributed Simulation Technology
ARPA	Advanced Research Projects Agency
ARSI	ARPA Reconfigurable Simulator Initiative
BLOS	Beyond Line of Sight
BLUFOR	Blue Forces
CDRL	Contract Data Requirements List
CEP	Concept Evaluation Program
CRP	Common Relevant Picture
CTDB	Compact Terrain Database
DA	Decision Aid
DMA	Defense Mapping Agency
DO	Delivery Order
DIFM	Distributed Interactive Fire Mission
DIS	Distributed Interactive Simulation
FBCB2	Force XXI Battle Command Brigade and Below
FRAGO	Fragmentary Order
GFE	Government Furnished Equipment
GUI	Graphical User Interface
LAT/LONG	Latitude/Longitude
LAN	Local Area Network
LI	Limit Indicator
LMC	Lockheed Martin Corporation
LMFS	Lockheed Martin Federal Service
LMSG	Lockheed Martin Service Group
ModSAF	Modular Semi-Automated Forces
MMBL	Mounted Maneuver Battle Lab
MTC	Movement to Contact
MWTB	Mounted Warfare Test Bed
OC	Observer Controller
OPFOR	Opposing Forces
OPORD	Operations Order

PC	Personnel Computer
PDU	Protocol Data Unit
POC	Point of Contact
PVD	Plan View Display
RPA	Rotorcraft Pilot's Associate
RTSMP	Real-Time Symmetric Multiprocessor
SA	Situational Awareness
SAF	Semi-Automated Forces
SOW	Statement of Work
STOW-E	Synthetic Theater of War-Europe
STRICOM	(US Army) Simulation Training and Instrumentation Command
TC	Tank Commander
TIM	Technical Interchange Meeting
TRR	Test Readiness Review
TTP	Tactics, Techniques, and Procedures
UDP	User Datagram Protocol
UFD	User Functional Description